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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Sanitation Guidelines for the Control of *Salmonella* in the Production of Fish Meal

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National Marine Fisheries Service, Circulars

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344. Bureau of Commercial Fisheries Tropical Atlantic Biological Laboratory progress in research 1965-69, Miami, Florida. By Ann Weeks. October 1970, iv + 65 pp., 53 figs.

346. Sportsman's guide to handling, smoking, and preserving Great Lakes coho salmon. By Shearon Dudley, J. T. Graikoski, H. L. Seagran, and Paul M. Earl. September 1970, iii + 28 pp., 15 figs.

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SANITATION GUIDELINES FOR THE CONTROL OF *SALMONELLA* IN THE PRODUCTION OF FISH MEAL

By

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ABSTRACT

A detailed description of the scope and magnitude of the *Salmonella* problem as it relates to the manufacture of fish meal is discussed. Specific control steps and procedures are outlined which, if followed, should keep *Salmonella* contamination to a minimum in fish reduction plants.

INTRODUCTION

Salmonellosis

Salmonellosis is a disease caused by eating food that is contaminated by bacteria known as *Salmonella*. There are over 1300 different types of *Salmonella*. The disease caused by these bacteria is usually characterized by fever, nausea, vomiting, and diarrhea. While there is no way to measure accurately the total cost of salmonellosis to our economy, the cost has been estimated to be at least $300 million annually. It has been further estimated that over 2 million individuals are infected with *Salmonella* annually. When one considers the associated costs of medical care and time loss at this attack rate and adds to this the substantial losses to the livestock and poultry industries, the $300 million appears to be a low figure.

How are Salmonellae Spread?

Salmonella normally inhabit the lower intestine of such animals as rodents and birds. Unpublished reports have indicated that up to 95% of all rat faeces are positive for *Salmonella*, and 40 to 60% of some wild bird species are positive. Carriers, that is, individuals which harbor salmonellae without apparent harm, occur both in human and domestic animal populations and are capable of spreading the infection to susceptible hosts.

Since the only way salmonellosis may be contracted is to ingest food which has either directly or indirectly been contaminated with faeces or urine from a diseased individual, transmission of the organism may be by direct or mechanical means. Methods of direct contamination are obvious. Mechanical transmission is facilitated by insects such as flies, roaches, spiders, weevils, beetles, etc., contaminated implements and clothing, and/or dust.

How is the Fish Reduction Industry Concerned with Salmonellae?

Scientists both in the United States and abroad have reported the contamination and recontamination of fish meal and scrap with *Salmonella*. Epidemiologists have suspected the source of *Salmonella* microorganisms in some cases of human salmonellosis to be from the fish meal portion of poultry feed. Eggs and meat have become indirectly contaminated from feeds, thereby causing outbreaks of salmonellosis when consumed by the unsuspecting public. As a result of such instances the Federal Government has recently banned the interstate shipment of fish meal and other animal feed ingredients contaminated with salmonellae.

SALMONELLAE CONTROL PROCEDURES

Research done by National Marine Fisheries Service (formerly Bureau of Commercial Fisheries) scientists has shown that a temperature of 190° F held for 10 minutes reduces salmonellae in fish meal to nondetectable levels. It is generally agreed that properly operated dryers being fed properly prepared scrap will permit the material to attain these time-temperature requirements. This being the case, when salmonellae are discovered in properly dried meal, the occurrence is a function of recontamination. This could happen in several ways. The following would be some of the most obvious:

1. Improper pest control program.
2. Improper building and/or equipment design.
3. Improperly operated equipment.
4. Employee malpractice.
5. Airborne contamination (dust).

All suggested preventive measures listed hereinafter will be aimed toward preventing recontamination by the above ways.

Plant Grounds

The grounds should be clean, orderly, weed-free, and cut routinely (Fig. 1). For those areas which are inaccessible to a mower, weed control may be implemented by chemical defoliants and other herbicides. Local extension county agents will be more than willing to advise those inexperienced in the use of chemical defoliants in the proper procedures to be followed. Extreme caution must be exercised in the use of those chemical defoliants in order to protect the environment from unwanted pesticide contamination, as well as to prevent erosion. A listing of chemical compounds approved by the U.S. Department of the Interior/U.S. Department of Agriculture is available from the Office of Fish Inspection, National Marine Fisheries Service, Washington, D.C. 20240. When plant grounds are properly

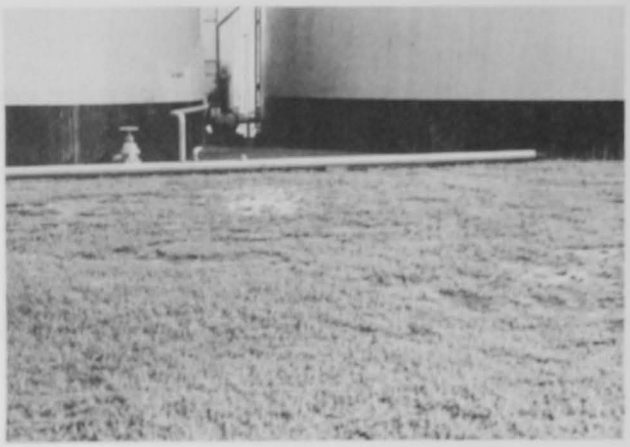

Figure 1. Properly mown and weed-free grounds.

maintained the incidence of ground rodents and insects is lowered. Crawling insects and other pests may also be controlled by the use of pesticides. Any pesticides used, however, should bear approval by the U.S. Department of Agriculture and be used according to the directions on the label.

The entire plant lot should be well drained and free of standing water. Additionally, all trash heaps should be removed and covered waste disposal containers should be provided.

Plant Buildings and Equipment

Plant buildings should be of sound construction and maintained in good repair. For purposes of a discussion of salmonellae control, any fish meal plant may be divided into two subdivisions, the pre- and post-dry areas. This division is based on the concept that it is possible to destroy *Salmonella* in the product prior to placing the meal in the storehouse. Once this is done, the next task the processor faces is to prevent recontamination of the meal in the warehouse (post-dry area).

Pre-Dry Area

All floors in the pre-dry area should be smooth and of a material which may easily be hosed down. Proper drainage is necessary in order to eliminate standing water, which provides a suitable environment for the breeding of flies and multiplication of microorganisms. Water should be removed as quickly as possible after accumulation. Inaccessible puddles of standing water may be eliminated as breeding

areas by covering them with pine oil until such time as they can be removed.

Raw material, defined as all fish material used in the production of fish meal prior to drying, should be processed as soon after unloading as possible. Cooking temperatures and times should be controlled to assure that the raw material is heated uniformly throughout.

Presses, cookers, and other raw material processing equipment in the pre-dry area should be readily accessible for cleaning, of sufficient design for the load, and as leakproof as possible. Press cake should never be allowed to remain in dryers and/or drags between runs, nor should dead fish be allowed to remain in conveyors or boxes, or on the ground.

Since processing operations usually begin before the temperature of all equipment has stabilized, it is recommended that a return screw conveyor or some other suitable device be installed from the dryer exit back to the cooker. After such installation has been made, all material passed through the dryer for at least the first 45 minutes of operation should be recycled back through the cooker. This should allow for a complete reduction of *Salmonella* in the press cake to a nondetectable level.

Post-Dry Area

Once the acceptable product is conveyed to the post-dry area, the next concern is to prevent recontamination of the product with *Salmonella*. The only way to receive a reasonable degree of assurance that recontamination does not occur is for the post-dry area to be a closed system from the dryer exit. All buildings in the post-dry area must have entryways and exits with self-closing doors and be screened. Any screening that is done in this area should be of the dual type—small mesh insect screen, covered and protected by the larger mesh "rat wire" (Fig. 2).

All ventilators and open eaves should be screened and open spaces in the walls where drags and conveyors enter the building should be tarred and pitched to prevent the entrance of insects and other vermin.

Walkways or driveways to and from the post-dry areas should be paved and kept clean and dry. If practical, these passageways should be

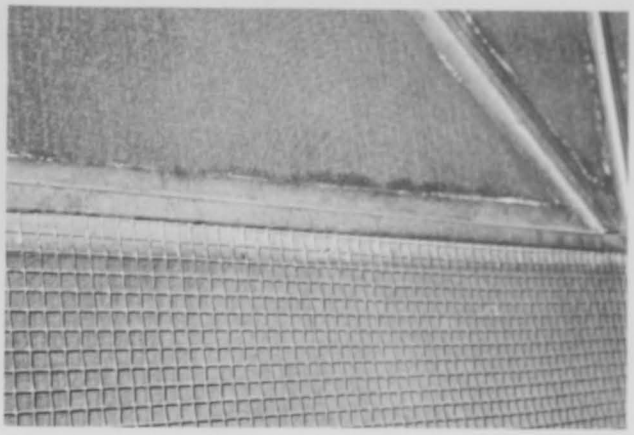

Figure 2. Dual type screening: insect screen covered with "rat wire."

covered. Any housing facilities for handling and storage; i.e., the post-dry areas, should have a concrete floor. Storage area walls, floors, and roofs should be leakproof to keep out moisture and to keep the processed product dry at all times. All conveyors in this area should be covered with metal covers and view plates should also be made of metal or transparent plastic (Fig. 3).

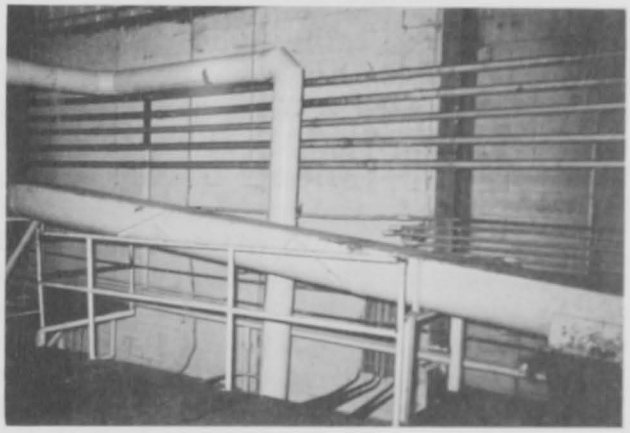

Figure 3. Properly covered conveyor.

A shallow pan containing a coconut fiber pad or other appropriate mat charged with an effective disinfectant should be placed by all entryways to the storage areas (Fig. 4). Phenolic, cresolic, or quaternary ammonic compounds are recommended as disinfectants. Hypochlorite types of disinfectants are not recommended since the bactericidal properties of these compounds are quickly lost and their use may represent a fire hazard. It is important that employees be trained in the proper use of

Figure 4. Foot bath at entry of storage area.

the foot bath, and that the bath be changed on a scheduled basis.

The concept of the closed system in the post-dry area must extend to the loading facility. It is imperative for effective *Salmonella* control that the loading of carriers be carried out under conditions which will prevent contamination. Therefore, a screened loading facility is recommended.

Cleaning and Disinfecting

Raw material should be removed from drags, conveyors, and the unloading area as soon as possible after unloading is complete. Slime and scales should be washed from drags and conveyors with high-pressure hoses. For cleaning pre-dry processing equipment, we recommend a cleaning agent in hot water solution used with a detergent gun or high-pressure jets to loosen and remove grease and other materials sticking to the surface. Following an effective cleaning, the equipment may be sanitized or disinfected. A disinfectant having recognized germicidal properties should be used. (Spraying the equipment with a solution of sodium hypochlorite providing 500 parts per million of available chlorine is satisfactory for this purpose.) It must be remembered, however, that all surfaces must be free of grease and accumulated material prior to applying the disinfectant solution.

All truck beds, tanks, barrels, etc. used to transport raw material to the plant may be adequately cleaned and disinfected as described above.

During plant operations the post-dry cleaning procedures should generally be confined to dust control. During the curing process for dried fish scraps, small particles of the processed material collect on the floor in the vicinity of the scrap pile and should be cleaned up during intervals when the conveyors are not operating. After fish scrap and meal have been moved out and the shed is empty, it should be cleaned of residues of scrap and dust before receiving new materials. Dust that accumulates on sills, shelves, rafters, and equipment should be removed frequently; this is easily accomplished by vacuuming (Fig. 5). All industrial vacuum cleaners discharging air in the warehouse should have their exhausts fitted with a filter to prevent airborne contamination. All cyclone stacks in the post-dry area should be fitted with spring activated dampers which will aid in dust control and prevent the entrance of pests and moisture during periods of inactivity.

Figure 5. Use of vacuum machine aids in dust control.

Containers and Transportation

Only new or sterile bags should be used for packaging processed material and the clean bag supplies should be stored in such a manner that they do not become contaminated.

The equipment used for transporting the processed material is a serious potential source for contaminating product during shipment. Generally, this equipment is not the property of the shipper, and thus there are acknowledged difficulties in maintaining it in clean condition. Even so, all equipment should be inspected before loading to see that it has been

properly cleaned. If it is not clean, it should receive proper cleaning. All carriers must be urged to cooperate in providing clean equipment.

Carriers may be fumigated with powdered formaldehyde or other effective bactericidal gas after a thorough cleaning, if necessary. Manufacturers' instructions must always be followed during the fumigation procedure.

Sampling and Laboratory Examination

Samples of the processed material at time of shipment should be periodically submitted for laboratory examination to determine the adequacy of the processing, handling, and storage methods (Fig. 6) in producing a *Salmonella*

Figure 6. One method for proper storage of the finished product.

negative product. These samples may be taken by several methods. Each sample should contain 10 subsample units of at least 50 grams each. Samples may be collected while vehicles are being loaded by passing a sterilized scoop through the stream of material. In this case the approximate amount of time for loading the vehicle should be determined, this to be divided by 10 and 50 gram subsample units taken at proper time intervals. For example, should it take twenty minutes to load a vehicle, each 50 gram subsample unit would be taken at two minutes.

Another method for sampling bulk which has been loaded upon a vehicle is indicated in Figure 7. Probes 1 to 8 should be inserted at approximately 10-15° angles from the vertical and approximately 10-12 inches from the edge

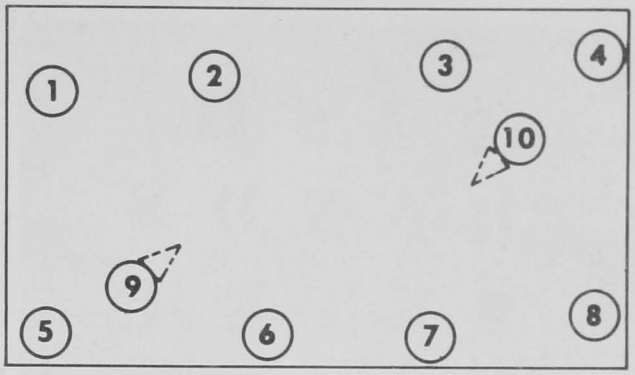

Figure 7. Diagram showing method of sampling bulk which has been loaded upon a vehicle.

of the vehicle bed. Probes 9 and 10 should be inserted at approximately 60-75° angles from the vertical and as far out from the edge of the vehicle as can be reached without entering onto or walking on the material. (Sampling procedures courtesy of the USDA.)

All containers and instruments used in collecting the samples and subsample units must be kept sterile to avoid carryover from one sample or subsample unit to another.

Salmonella negative material may be defined as that processed material in which the presence of *Salmonella* is not detectable when sampled by procedures outlined in this guideline and subjected to a laboratory examination. The laboratory examinations should be done as outlined in USDA publication (ARS 91-68) "Recommended Procedure for the Isolation of *Salmonella* Organisms From Animal Feeds and Feed Ingredients."

Should the laboratory examination of the processed products reveal contamination, the sanitation procedures of the plant should be reexamined and corrective measures must be instituted.

Personnel

A sanitation officer should be appointed to ascertain that all aspects of these guidelines are carried out. All employees should be thoroughly instructed in plant sanitation guidelines and in the need for strict adherence to an accepted set of procedures (Fig. 8). Those personnel who work in the pre-dry area—including areas used for unloading, weighing, transporting, handling, or storing raw fish—should not work in the post-dry area and

Figure 8. Instructional signs remind employees of proper sanitary procedures.

vice-versa without proper training. It is recommended that specially marked outer clothing, caps, and footwear be provided the employees that will readily identify their work area.

Adequate washing, showering, dressing, and toilet facilities must be provided for all employees.

Management Responsibility

There are certain basic and fundamental responsibilities the management of plants must accept for the implementation of these guidelines. First among these is the commitment to adequately fund a plant sanitation program. Unless such a program receives necessary funds, these guidelines cannot be effectively implemented. Secondly, there must be appointed at both the plant and corporate level one reliable individual who will be responsible for carrying out these guidelines. These individuals must interest all of the employees in proper sanitary practices. To do this, specific training sessions with films or other audio-visual aids may be used to explain the importance of good sanitary practices. All plants must be willing to undertake effective pest control programs. In many instances, it may be desirable to contract to outside individuals this function of the program. Finally, it is the responsibility of plant management to insure that good operational procedures are set forth in the day-to-day operation of a plant and that proper cleanup procedures are practiced. An excellent way to document proper operating and cleanup procedures is for a responsible individual to inspect the plant each day recording the inspection results on a score sheet (Fig. 9).

SUMMARY

1. Salmonellosis is a serious disease that may infect humans indirectly through animals which have eaten contaminated feeds.

2. The organisms are reduced to non-detectable levels in fish meal when subjected to 190° F for 10 minutes.

3. Processed material should be negative for salmonellosis when exiting properly operated dryers. To make certain, however, the finished material from at least the first 45 minutes of production should be recycled back through the cookers.

4. *Salmonella* recontamination of the fish meal product can be controlled if the following preventive measures are taken:

   a. Prevention of the indiscriminate transfer of men and equipment from the pre-dry area to the post-dry area.

   b. Prevention of excessive moisture and dust accumulation in the post-dry area.

   c. Proper pest and vermin control is maintained throughout the plant.

   d. Proper cleaning in the pre- and post-dry areas of the plant is maintained.

   e. Proper storage and shipment of the final product is carried out.

It must be recognized that currently *Salmonella* cannot be eradicated from fish meal. Therefore, a manufacturer can only hope to "minimize the risk." It is presently technically impossible to guarantee that a fish meal product is free of *Salmonella* microorganisms unless the product has been terminally treated. Sufficient data have been collected, however, to justify a statement that under good operating conditions, the probability of isolating salmonellae from the finished product is low. The purpose of these guidelines has been to delineate those "good operating conditions."

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANOGRAPHIC ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

SANITATION SCORE SHEET FOR FISH REDUCTION PLANTS

Plant:	Address:	Date: Time: Region:

Rating Symbols: S - Satisfactory
NI - Needs Improvement
U - Unsatisfactory

Area and Items	S	NI	U	Explanation
Loading Facility				
1. General cleanliness				
2. Transport vehicles cleaned				
3. Structural integrity of vehicle				
4. Loading equipment				
5. Screening and dust control				
6. Other (specify)				
7. Other (specify)				
Warehouse (Finished Product)				
8. Structural Integrity				
9. Screening				
10. Disinfection station				
11. Dust control program				
12. Drags				
13. Pest control program				
14. Implement storage				
15. General cleanliness				
16. Personnel traffic control				
17. Implement traffic control				
18. Other (specify)				
19. Other (specify)				
20. Other (specify)				
Process Area				
21. Cyclones				
22. Conveyors				
23. Dryer(s)				
24. Cooker(s)				
25. Raw box(es)				
26. Dump box				
27. Processing water				
28. Other water supplies				
29. Other (specify)				
30. Other (specify)				
Plant grounds				
31. Weed control				
32. Standing water				
33. Dust control				
34. General cleanliness				
35. Waste disposal				
36. Other (specify)				
37. Other (specify)				
Materials Storage Area				
38. Chemicals				
39. Tools and machinery				
40. Other (specify)				
Vessels				
41. General cleanliness of decks				
42. Sanitization of pumps and screens				
43. Sanitization of holds				
44. Other (specify)				
45. Other (specify)				
Vehicles for Transporting Raw Material				
46. Specified area for cleaning				
47. General cleanliness of vehicle				
48. Other (specify)				
Personnel				
49. Outer garment				
50. Work area identification				
51. Employee training				
52. Other (specify)				
53. Other (specify)				
Rest Rooms				
54. Toilet facilities				
55. Wash basins				
56. Floors and walls				
57. Supplies				
58. Other (specify)				
59. Other (specify)				

Figure 9. Sanitation score sheet for fish reduction plants.